Evolution of Piping as an Engineering Discipline

Author delves into evolution of piping as an engineering discipline since 1979/1980 through 1989/90 and beyond to the millennium. As also, how it is being corroborated with the Plant Operator/Owner by a Process Plant Piping Engineer. Even piping material and its choice by weighing pros & cons has significantly evolved/ developed through continuous improvements based on feedback taken by piping manufacturing giants/ steel mills around the globe. By doing so, ultimately in the long run, operating a Process Plant becomes cost-effective.

Pipes are erected and routed both Inside Battery Limits (ISBL) and Outside Battery Limits (OSBL) of a given Process Unit. The scheme is decided by the plant/equipment layout/piping General Arrangement Drawings (GAD) which are then to be converted to isometrics for use by the fabrication yard at site utilising Specified Quality of Piping Materials. All the Shop-joints are subjected to Radiography & DP tests, referred to as Non- Destructive Tests (NDT).

80's through the 90's to the millennium

A Pre-Fabrication Shop was set up at Kandla Free Trade Zone (KFTZ) in 1982 facilitating Export of Piping Spools to Middle-East based on Approved for Construction (AFC) drawings, piping layouts and piping isometrics of a given project. Planned percentage of Piping-spools' tonnage can be achieved owing to deployment of 6G Qualified Pipe Welders on daily basis.

In 1985, when Plants for Man-Made Fibres were being constructed, in which Process Plant Building had pipes running ISBL to the tune of multiple times 100,000 inch-metre of erection, isometrics in bulk quantity were to be produced based on equipment and piping layouts.

The process of rolling out the Piping Isometrics would be error – free, which was the clear indicator of high productivity. This involved training the designers at the design centre for 2D depiction of isometrics. To achieve highest orders of productivity, develop error-free isometrics as well as to cope up with the schedule of the erection contractor, we developed the novel idea of using flexible copper wire as the demo tool. The wire could be shaped, bent and rolled to resemble a piping run or isometric

Then, in 1990, we migrated to Plant Design System (PDS) 3D - modelling for implementing it on a Pilot Project of Non-tearing Paper. In 3D environment we would extract Pipe Isos which further would depict various kinds of pipe-support, its type being decided by the outcome of Piping Stress Analysis. In the Millennium Year, one could achieve a higher productivity in the generation of Layouts and Isometrics using Plant Design Management System (PDMS), 3D Modelling.

Handling the Stress

In effect, for completeness of Piping System, what is required is the method of holding pipes on to supports that can absorb stresses developed owing to thermal loads when routing the piping loops on to concrete sleepers or on to the pipe-racks (could be concrete columns & beams or simply steel structure). Stress Analysis of various test-packs or loops based on AFC P&IDs ought to be carried out using a universal programming tool.

Process Piping arrangement and its induced stress as a result of high pressure & temperature of the fluid depending on kinematic viscosity and flow rate, need to be anchored or moving / sliding on to a variety of supports that are either custom-built or like in case of spring-hanger supports are required to be calibrated to match the functional design of the piping system in question.

In the designing of piping system, care has to be exercised in choosing the extent of radius in various bends that come into play lest stress concentration occurs, resulting in fatigue failure of materials or offset of pipe lengths while the plant is in running condition, including unseating of pipe from its support, e.g. hanger-type support.

Heat & Mass Balance is done through Steady State Modelling and results are tabulated in PFD (Process Flow Diagram) based on which Material of Construction (M.O.C.) of Equipment & Piping is decided. Bearing the above in mind, one is required to select the M.O.C. of piping material, at the same time addressing the materi al handling and ease of erection issue.

To cite one example of H.P. Steam process piping material, what comes immediately to mind is Deustche Babcock Werke (DBW) developed Piping Material thus X20Cr Mo V121 alloy that has thin Pipe-thickness even for large diameter Pipes.

Layout & Designing

In Piping Engineering or Equipment Layout Designing, P&ID the deliverable of

Process Engineering department becomes the governing document for planning of TEST PACKS for Hydro-testing purposes. Upon successfully testing of individual test-packages, System-wise sizable number of lines are brought together for Hydro-Testing purpose. Likewise, other process and utility systems are successfully hydro-tested. Ultimately, all the systems that qualify for hydro-test are joined with match-points to ensure that the said Plant is ready for trial-runs. Finalisation of plant layout is based on operating and control philosophy covering its start-up and running as well as during its shut-down times. After all, layout of Plant is based on Safety studies & governing guidelines.

Design of Process Plant Layout ought to address crucial aspects of Protection, e.g. leaks, liquid overflow, excess temperature, etc. Any revision in Piping System has to be verified by carrying out stress analysis and not otherwise. The design pressure of each component in the Piping System will be equal to the most severe pressure expected during service. Surge effects, e.g. water-hammer is analysed and pipe-supports are designed to withstand such loads.

Slug flow or force is yet another aspect that comes into play during the flow of gas & liquid simultaneously in a piping system, when the slug is having higher velocity than the Mean Velocity of a 2-phase flow. The resultant impact force is calculated as a Dynamic Amplification Factor (DAF), which occurs due to change in fluid direction.

Subsequent to building of a Process Plant's Equipment Layout at the hands of the Plant Owner &/or its 3rd Party Approver, the GADs are rolled out and piping isometrics generated and plant design completed. Application or implementation of concurrent engineering is then executed by way of incorporation of other engineering disciplines' interference checks for routing of process pipes.

A 'FLY-BY' 3D Model is saved and handed over to the client for the purpose of maintaining the record and future use for modification of plant, when the need arises. In case, the client wants to capture the physical dimensions of each and every component that has gone into his Process Plant, the same is made possible through 'Laser Grammetry', by means of which the Point Cloud Data gets converted to images and pictures are formed through a compatible camera, viz., Leica Brand Camera handled by trained operators positioned within the main process plant building. ■

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